Microresonator for the ESR and ODMR experiments

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The traditional high-Q ESR resonators are on the limit of their performance for pulsed ESR experiments on very dilute spin samples, especially when the optical access to the sample is desired. Other parameters being equal, the sensitivity of the resonator can be increased for small samples by minimizing its size and thus increasing the filling factor. In contrast to cavity type resonators, microcoils can be made much smaller than the operation wavelength. For this type of resonator, it has been established theoretically and experimentally that the sensitivity varies inversely with its linear dimensions [1]. Within the QIPDDF-ROSES project, we plan to use such resonators to measure the EPR parameters of monolayer molecular films of N@C60. Moreover, the planar coil geometry is ideal to be manufactured in a small size by means of standard microtechnology. It also offers unrestricted optical access for ODMR experiments and offers advantages for the excitation of electron spins in prototype quantum computer systems.

In order to optimize microcoil tuning circuits and sensitivity the prototype of the coil with feeding microstrip line was made on the FR4 substrate through a standard PCB fabrication process (Fig.1).

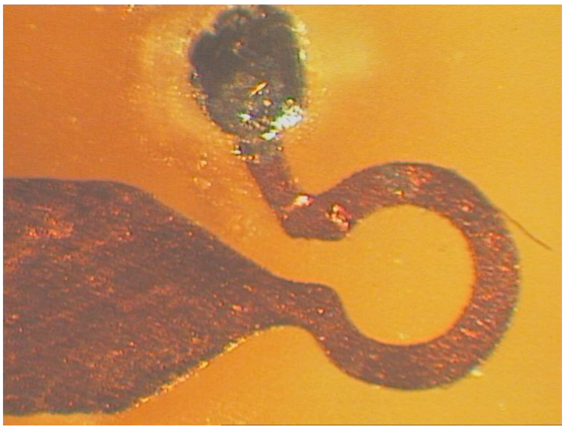

Fig. 1. The coil with the microstripline on the FR4 substrate. Coil diameter 550 μm, trace width 160 μm.

Tests of this coil in an ODMR setup proved that the microcoils are well suited for efficient single spin manipulation. We demonstrate that π-pulse in experiments with single N-V defect in diamond can be as short as 10 ns. ODMR experiments [2] on single defect in diamond can be performed at room temperature because of spin alignment related to optical pumping. Fig 2 shows the transient nutation of single electron spin under permanent optical excitation. Coherent Rabi oscillations of the single spin Y-Z electronic transition are visible. Fast decoherence processes (T_2 = 300 ns) are caused by continuous laser illumination and can be suppressed by state preparation under dark conditions.

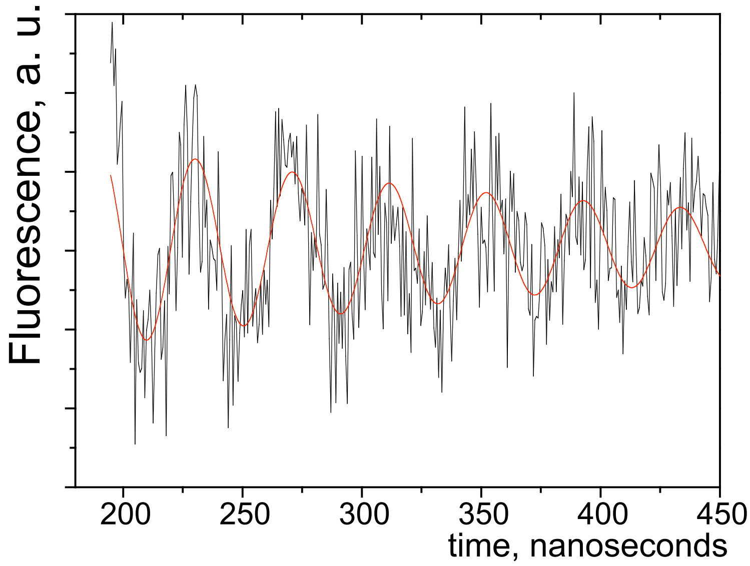

Fig. 2. Spin nutations from single N-V defect in diamond.

References

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